

CONTINUATION
of
Application S.N. 09/590,633 filed June 8, 2000
To Reissue
United States Letters Patent No. 5,764,724

To all whom it may concern:

Be it known that I, Carl-Eric Ohlson

have invented certain new and useful improvements in

**METHOD OF MAKING X-RAY PHOTOGRAPHS OR EXPOSURES OR OTHER TYPE OF
RADIATION SENSING, SUCH AS ELECTRONIC IMAGE STORAGE, AND A PATIENT
TABLE HAVING A RECEPTOR UNIT FOR SUCH PHOTOGRAPHY, EXPOSURE OR
IMAGE STORAGE**

of which the following is a full, clear and exact description:

**METHOD OF MAKING X-RAY
PHOTOGRAPHS OR EXPOSURES OR
OTHER TYPE OF RADIATION SENSING,
SUCH AS ELECTRONIC IMAGE STORAGE,
AND A PATIENT TABLE HAVING A
RECEPTOR UNIT FOR SUCH
PHOTOGRAPHY, EXPOSURE OR IMAGE
STORAGE**

REFERENCE TO RELATED APPLICATION

This patent application is a continuation of reissue application Ser. No. 09/590,633 filed on June 8, 2000 to reissue original Patent 5,764,724 granted on June 9, 1998.

TECHNICAL FIELD

The present invention relates to a method of imaging a person or an object in at least two directions by X-ray photography, while using an X-ray cassette as a receptor or other forms of radiation-absorbing techniques with the aid of a radiation receptor, for instance for electronic image storage.

In imaging processes of this kind, there is used a radiation source which is supported for movement in X-, Y- and Z-directions and which is rotatable about a horizontal axis. The receptor unit may be mounted in or positioned beneath a patient table and is movable in the X-direction. Movement of the radiation source may be initiated automatically, as the receptor unit is moved.

By X-direction is meant here and in the following a direction of movement which is parallel with one long side of the patient table, while by Y-direction is meant a direction of movement perpendicular to the extension of said long side, i.e. a direction of movement parallel with the short sides of the table. By Z-direction is meant movement in a vertical direction. This enables the patient table to be brought to different positions in relation to a tower column or a ceiling-mounted tower which carries the beam source.

The present invention also relates to a patient table equipped with a receptor unit, and more specifically to a patient table of the kind defined in the preamble of claim [5] 8.

BACKGROUND PRIOR ART

GB-B-1,323,769 (Picker Corp.) describes apparatus comprising a receptor part disposed in a patient support table, and an overlying ceiling-mounted beam source. The apparatus enables side-on photographs to be taken with a horizontal beam path, by swinging-up the patient's support table about a horizontal axis and pivoting the beam source. The apparatus also enables the image size and the shutter setting to be varied in relation to the beam-source/receptor distance ("SID", i.e. "source-image-distance". However, movement of the beam source and swinging of the patient support table must be effected manually, which is experienced as troublesome by the radiologists concerned.

EP-A-0 430 934 (AO Medical Products) describes a method of the aforesaid kind in which activation of a secondary receptor pivotally associated with the receptor unit or mountable thereon and extending in a vertical plane results, optionally after a time delay, in automatic movement of the beam source to a basic setting for horizontal, centered beam path onto the secondary receptor.

A Philips brochure describes a patient support table which carries a receptor unit for a vertical beam path. This receptor unit can be swung outwards and upwards from one side of the table, to a position for receiving a horizontal beam path.

This latter arrangement, which is considered to represent the nearest prior art, has a number of drawbacks. When the receptor unit is to be swung out and up to receive a horizontal beam path, it is necessary for personnel who need to stand on the other side of the table in order to manoeuvre

the beam source to move around the table to swing the receptor unit outwards and upwards, and then move back around the table and place themselves in their original position in which the beam source can be manoeuvred. This procedure is experienced by the personnel as being both troublesome and time-consuming. The described solution also has other drawbacks from an ergonomic aspect.

Another drawback is that the receptor unit is not centred in relation to the beam path when swung outwards and upwards from the table, and it is therefore necessary to move the beam source in the X-direction when adjusting for horizontal beam path.

Furthermore, this known arrangement only allows an exposure to be taken from one side of the patient. It is often difficult to "turn" the patient, particularly when the patient is seriously injured.

The effect of these drawbacks may sometimes be so serious as to impair the clarity of the pictures to an extent such as to require the X-ray to be taken again, therewith exposing the patient to an unnecessarily high radiation dosage.

THE OBJECTS OF THE INVENTION

One object of the invention is to provide a method and a patient support table of the aforesaid kind which, with one and the same receptor equipment, enables pictures to be taken with a vertical beam path, for instance with the patient lying down, and also with a horizontal beam path from each side of the patient support table, and preferably without changing the setting of the beam source in the X-direction, i.e. without moving the beam source laterally.

Another object is to provide equipment of the aforesaid kind which is superior to earlier known equipment with regard to ergonomics.

A further object of the invention is to provide equipment which can be adapted readily to different specific parameters, such as receptor size, table width, etc.

BRIEF DESCRIPTION OF THE INVENTION

These and other objects are fulfilled with a method of the kind defined in the preamble of claim 1 and having the features set forth in the characterizing clause of said Claim.

The invention enables the beam to be kept central in the Y-direction in the transition between a vertical and a horizontal beam path, irrespective of the alignment of the horizontal beam path in the Y-direction. In addition, the invention enables a receptor that has been swung up to a position above the table to be moved towards the patient and therewith obtain optimum picture sharpness and therewith a clearer diagnosis from the picture or image obtained.

The invention also enables the positions of pivot centres to be determined accurately in accordance with the different parameters that apply in individual cases, for instance in accordance with the dimensions of the receptor unit, the width of the patient support table, the desire for the bottom edge of the receptor to be located at a given height above the table when the receptor is in an outwardly swung position, and so on.

The present invention also enables the introduction of mutually dependent locking facilities with a crosswise function for outward swinging of the receptor unit in the horizontal plane. The effect afforded by the invention can be likened to the hinge of a hinged door, i.e. the receptor can present alternative pivot centres in dependence on the direction in which the receptor unit is swung outwards. Left and right pivot centres can be readily adapted to occurrent types of tables.

In practice, it is preferred that respective pivot centres are so placed in the X- and Y-directions that centering of the beam source in the X-direction will be the same for both a horizontal and a vertical beam path. A preferred method according to the invention is characterized by swinging the receptor unit in one or both of the alternative outwardly and upwardly swung positions to a position in which the unit is perpendicular to the longitudinal axis of the table, therewith enabling X-ray pictures to be taken of a patient seated in a wheelchair, for instance.

This enables the requirement of a separate frame or stand for taking such pictures to be dispensed with. This special outwardly swung position of the receptor unit may also be used in other circumstances, for instance when taking lung X-rays, etc.

In one preferred method of applying the invention, the receptor unit is movable in the X-direction along the longitudinal axis of the table with corresponding automatic movement of the beam source and resetting of said source for a horizontal beam path towards the receptor unit, after having swung the receptor unit outwardly and upwardly beyond a side edge of the table.

Thus, in the case of this preferred method of application, the beam source is adjusted automatically to the position adopted by the receptor unit.

In accordance with one method of application, the receptor unit is supported by a carriage which can move in the X-direction relative to the table and which can also be moved in the Y-direction relative to the carriage. The unit is carried by arms whose lengths can be adjusted and which supports the unit stably and reliably.

In this method of application, the receptor unit can be dropped down or raised up from an outwardly swung horizontal position on each side of the table, to a respective vertical position beneath or above the table, by pivotal movement about mutually parallel axes located at different levels.

When in an outwardly swung and upwardly lifted vertical position, the receptor unit can be swung about a central, vertical axle for work with an angled beam path.

According to another aspect, the invention also relates to a patient support table provided with a receptor unit and intended for X-ray photography or X-ray exposure or some other type of beam sensing, e.g. electronic image storage, said patient support table being characterized essentially by the features set forth in the following claims 8-16.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail with reference to exemplifying embodiments thereof and also with reference to the accompanying drawings, in which

FIG. 1 is a perspective view of a receptor unit which can be swung outwardly and upwardly in different directions in accordance with the invention and which is mounted on a patient support table shown in chain lines;

FIG. 2 is a perspective view of the patient support table shown in FIG. 1 with the receptor unit in an outwardly and upwardly swung position, referenced C, to the right of the patient table, wherein the Figure also shows a number of possible alternative positions of the receptor unit, referenced B, D, E, F and G respectively, wherein the initial position shown in FIG. 1 is referenced A;

FIGS. 3-9 show the patient support table from above with respective receptor units in the aforesaid different positions, wherein FIG. 3 corresponds to positions A, FIG. 4 corre-

sponds to position B, FIG. 5 corresponds to position C, FIG. 6 corresponds to position D, FIG. 7 corresponds to position E, FIG. 8 corresponds to position F and FIG. 9 corresponds to position G;

FIG. 10 is a view of the patient support table shown in the other Figures from above, with the receptor unit shown in positions A and B, wherein the Figure also shows a number of reference signs relating to different relevant measurements and distances regarding the patient support table and the receptor unit respectively as explained in more detail below, and wherein the figure thus illustrates the geometric relationship between occurrent magnitudes;

FIG. 11 is a side view illustrating different receptor positions;

FIG. 12 is a simplified principle perspective view of a modified design of the patient support table, in which the receptor unit is accommodated in a carriage which can be moved along the table in the X-direction and is so mounted in the carriage as to be also movable in the Y-direction;

FIG. 13 is a perspective exploded view illustrating some of the elements by means of which the receptor unit is supported by the carriage for movement in the Y-direction;

FIG. 14 is a perspective view of the table and the carriage-supported receptor unit in a position in which the unit lies partially outside the table, i.e. prior to swinging the receptor unit outwards;

FIG. 15 is a perspective view corresponding to the view of FIG. 14 and shows the receptor unit swung out away from the table;

FIG. 16 is a perspective view corresponding to the view of FIG. 15 but showing the receptor unit swung to a vertical position;

FIG. 17 is a perspective view of the arrangement shown in FIGS. 12-16, wherein the receptor unit has been swung down to a vertical position about an axle which is parallel with the axle used to swing-up the unit, this downwardly swung position being used, for instance, to take X-rays of the knees of a seated patient;

FIG. 18 is a perspective view of parts of those elements which function in the linear and pivotal movements of the receptor unit;

FIG. 19 is a perspective view showing that the receptor unit can be swung about a vertical axle relative to its carrying means, so as to enable pictures to be taken with an angled beam path; and

FIG. 20 is a perspective principle view illustrating some of those positions to which the receptor unit can be adjusted by means of the carrying and journalling arrangement shown in FIGS. 12-19.

DESCRIPTION OF PREFERRED EMBODIMENTS

The reference numeral 1 used in the various Figures identifies a patient support table for use in X-ray photography or in some other type of beam sensing, such as electronic image storage, for instance. The patient support table is supported on telescopic legs 1a provided with floor plates 1b, which enable the table to be adjusted vertically.

The table includes a recess or aperture 5 for the accommodation of a receptor unit, generally referenced 2. The receptor unit can be moved in the X-direction, i.e. in the longitudinal direction of the table. Some of the FIGS. 3-9 show an X-axle in the centre of the table. To this end, the receptor unit may be mounted on a carriage or like device (not shown) mounted in the table.

The receptor unit 2 is intended for coaction with a beam source (not shown) which can be moved in the X-direction, the Y-direction, i.e. transversely to the long axis of the table, and in the Z-direction, i.e. in a vertical direction. The beam source can also be swung about a horizontal axle.

The receptor unit 2 is supported by arms 7, 9 which are joined together via a link 8 and which coast with pivot centres 11, 12 having vertical pivot axes located in the region of each side edge of the table, such as to enable the receptor unit to be swung out to alternative positions on each side of the table. The arm 9 is connected to the receptor unit 2 by means of a horizontal hinge 10. The receptor unit 2 can thus be swung out from the initial position A shown in FIG. 1 to the position B shown in FIG. 2, this latter position also being shown in FIG. 4.

The receptor unit shown in FIGS. 3-9 correspond to the receptor unit shown in FIGS. 1 and 2, with the exception that the units shown in FIGS. 3-9 have a handgrip 2a which enables the receptor unit to be swung manually. The receptor units are also provided with an operating panel 2b having push buttons by means of which different receptor locking and receptor release operations can be initiated, the beam source activated, etc.

The receptor can be swung up about the horizontal hinge 9 from the position B shown in FIG. 4 to the position C shown in full lines in FIGS. 2 and 5.

The vertical axle 11 enables the receptor unit to be swung from position C to a position D, shown in FIG. 6, in which the receptor unit is at right angles to the table 1. With the receptor unit in position D, side-on pictures and front-on pictures can be taken of a patient seated in a wheelchair, for instance.

In FIG. 7, the receptor unit 2 has been swung from the initial position shown in FIGS. 1 and 3 in the other direction, about the vertical axle 12, to the position E in which the receptor unit is located slightly outside the opposing side edge of the table. It will be seen that in this position the receptor unit is also centered in the X-direction, i.e. there is no need to move the beam source laterally.

The receptor unit can be swung up from the position E shown in FIG. 7 to the position F shown in FIG. 8.

FIG. 9 illustrates the receptor unit swung from position F to position G, this position corresponding to the position D on the other side of the table.

two pivot centres 11 and 12 can be determined as desired, in a manner described in more detail below.

The pivot axle about which the receptor unit is swung up is placed so that when the unit is in an upwardly swung position, the bottom edge of the unit will be located roughly in the plane of the table top or above the table top, for instance at a distance of 20 mm therefrom.

One advantage is that the operating unit 2a, 2b is located on the same side of the table as the radiologist or his/her assistant, therewith facilitating operation.

FIGS. 10 and 11 illustrate different conceivable component measurements and the distances therebetween. The measurements also correspond to a left-hung receptor unit. In the initial position of the receptor unit

- a) is the width of the receptor unit in the X-direction;
- b) is the length of the unit in the Y-direction;
- c) is the distance between the two pivot centres 11 and 12;
- d) is the width of the table;
- e) is the distance in the Y-direction between the receptor unit and the pivot centre 11;
- f) is the distance between one side edge of the table and the pivot centre 12;
- g) is the distance in the Y-direction between the opposite side edge of the table and one end edge of the receptor unit in position B;
- h) is the distance between this last-mentioned side edge and the pivot centre 11;
- x) is the distance in the X-direction between the centre point of the receptor unit in position A and the pivot centres 11, 12;
- y) is the distance in the Y-direction between the centre point of the receptor unit in position A and the pivot centres 11, 12; and
- h) is a radius corresponding to the length of the link 8.

The following relationships will thus apply:

$$\begin{aligned} x &= Y = z/2 \\ c &= (c-b)/2 \\ f &= (d-c)/2 \\ g &= (2 \times c - a - d)/2 \\ h &= (c-a)/2 \end{aligned}$$

Table 1 below lists measurements which can be applied and calculated with regard to a constructional design preferred in practice.

TABLE 1

Receptor width a	Receptor depth b	Variable Axle distance c	Table width d	Distance centre Receptor e	Variable Centre Receptor f	Receptor Plate g	Center Receptor h
479	580	590	700	20	55	1	56
564	580	590	700	20	55	-42	13
479	580	600	700	40	50	11	61
564	580	600	700	40	50	-32	18
479	580	610	700	60	45	21	66
564	580	610	700	60	45	-22	23

The various Figures illustrate that when applying the inventive method, the beam can be kept centered in the X-direction in the transition between the vertical beam direction and the two horizontal beam directions, in accordance with the position shown in FIGS. 1 and 2 and in FIGS. 7 and 8 respectively. At the same time, the positions of the

The Table shows the aforesaid relationships in one application example, in which c and f are variables.

FIGS. 12-19 show a modified design of the receptor unit 2, to-wit a design in which the receptor unit is carried for movement in the Y-direction by an element 15 which may either be part of a carriage which can be moved in the